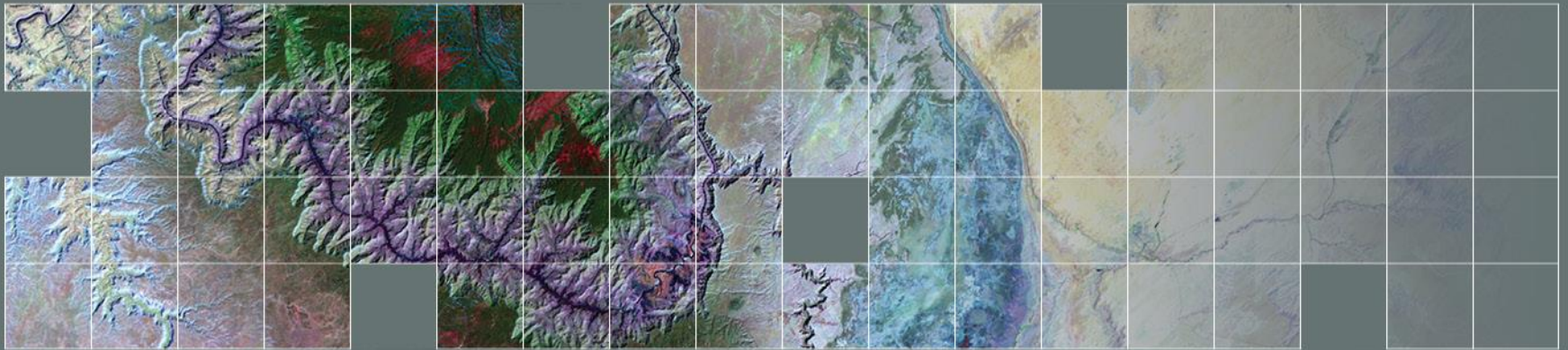




Climate and Land Use Change
Earth Resources Observation and Science (EROS) Center

A look at WorldDEM and Proba V data



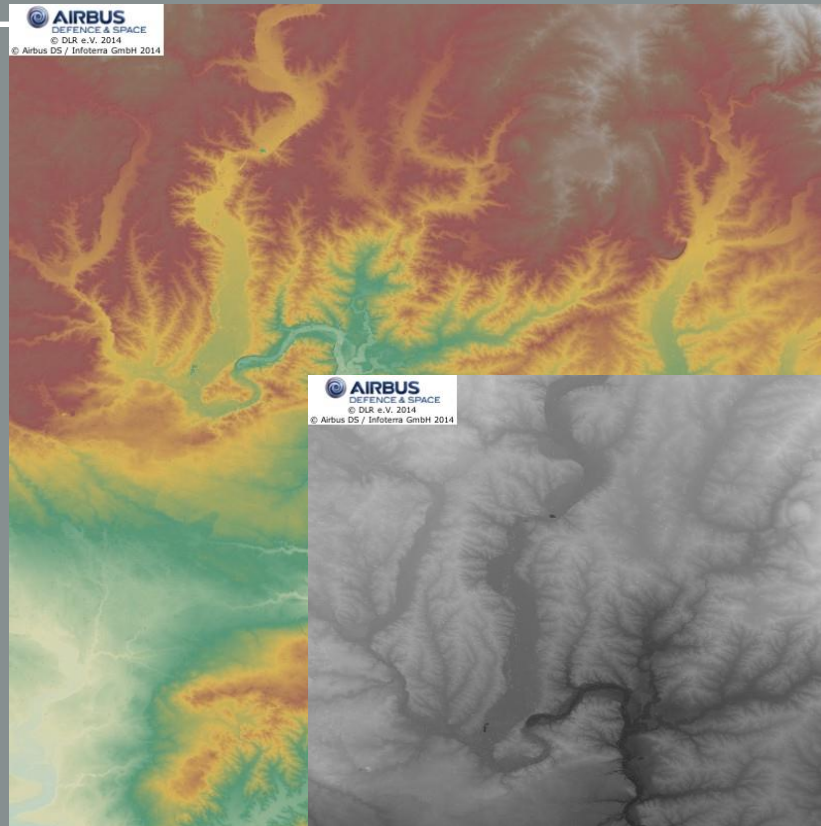
**Md. Obaidul Haq,
Ajit Sampath**

Outline

- **WorldDEM**
 - Data Overview
 - Assessments
 - GCPs from DGPS
 - Lidar
- **Proba V**
- **Summary**

WorldDEM Data

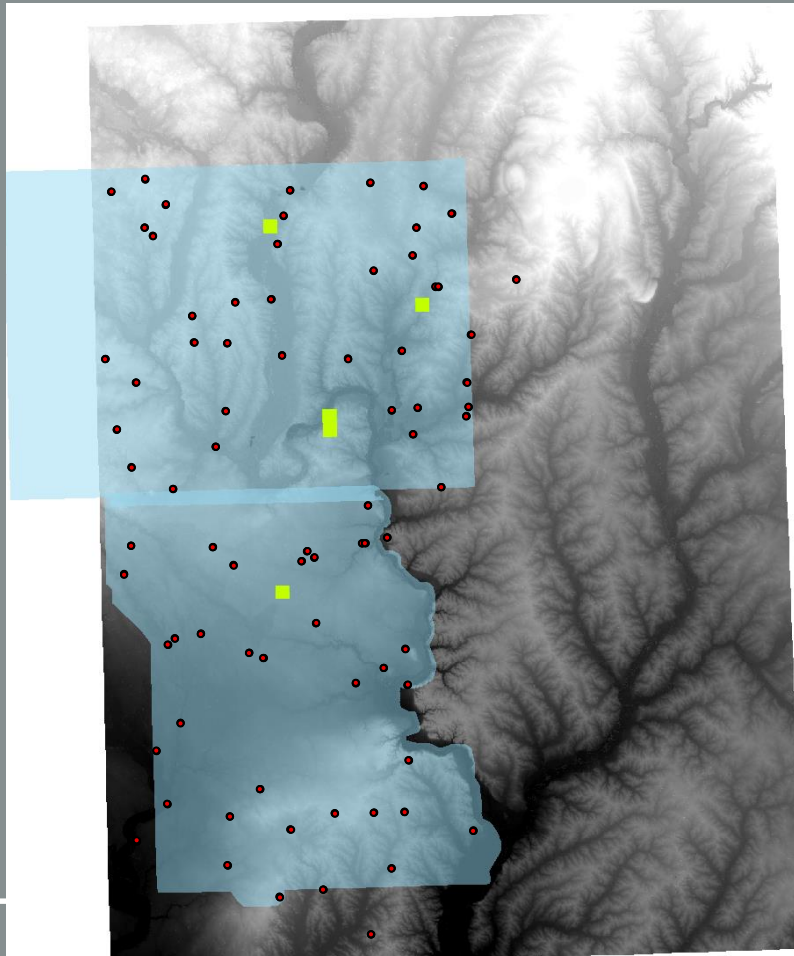
- Data in Geographic coordinates
- Minnehaha and Lincoln Counties, SD and Parts of Iowa
- Pixel GSD .0001 degrees
- EGM2008 vertical datum, Units: meters
- Data Projected to UTM, GSD 10 m.



Reference Data

- **Post Processed Kinematic GPS Survey**
 - Over 75 Locations
 - Collected in Summer 2014 to support data analysis as well as part of EROS 3D Range
 - Flat areas
 - At least 30 m away from vertical structures
- **Within 7-12 cm vertical accuracy**
- **Lidar Data**
 - 5 ft Point Spacing
 - About 13 cm vertical accuracy

Reference Data



Tests

- **GPS Data used to check elevation in flat areas**
- **Lidar Data used in sloping areas**
 - Good correspondence in heights between Lidar and GPS based points in flat areas
 - Higher Slopes also corresponded with areas of high vegetation
- **GDAL and ArcPy used for tests**

Results

■ GPS Points

- Mean: 0.76 m
- Standard Deviation 1.89 m
- RMSE: 2.05 m
- Matches well with WorldDEM specifications of 2 m Relative and 4 m absolute vertical accuracy

■ Lidar Data

- Similar results to GPS data on Lower Slopes
- Higher slopes in the test area are mainly vegetated
 - Different penetration of Lidar and Radar data into vegetation renders comparison questionable and is excluded for the present
- Note that study area is mostly gently rolling terrain
 - Higher slopes present along river valleys with vegetation

Continuing Work

- **Horizontal Resolution Estimation**
- **Evaluation in high terrain low vegetation areas**
- **Slope and Aspect Comparisons**

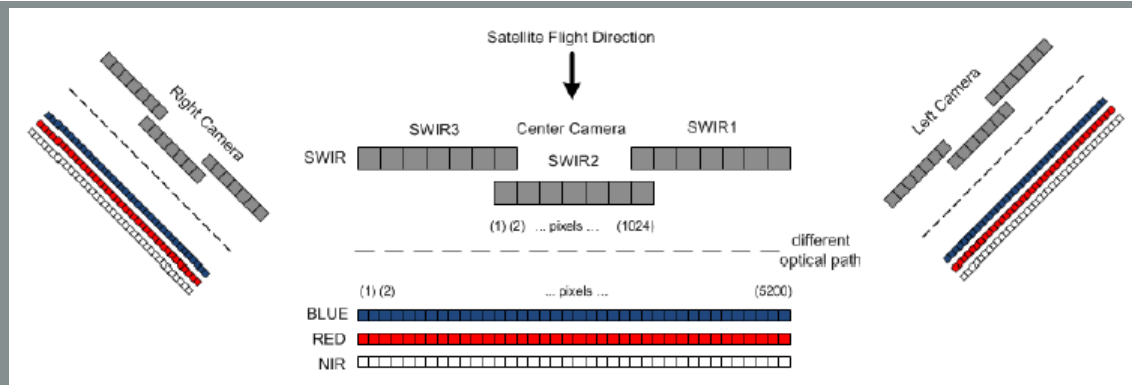
Proba V Overview

- Project for On-Board Autonomy (Vegetation) or Proba-V was launched at 6 May 2013
- Objective: to bridge the gap between SPOT-VGT and Sentinel-3 for space borne vegetation measurement

Altitude	820 km
Local overpass time at launch	10:45 h
Inclination	Sun-Synchronous Orbit
Coverage	90% daily, 100% every 2 days
Payload Mass	33.3 kg
Payload Dimensions	0.2 x 0.8 x 0.35 m ³
Designed lifetime	2.5 - 5 yr

Source: Proba-V Products User Manual

Proba-V Instrument Layout



- Field of view: 102°
 - Swath width: 2295 km
 - Number of cameras : 3
 - Observation time difference between NIR & SWIR : 12 s
 - GSD : VNIR 100m at Nadir 350m at extreme edges
 - GSD : SWIR 180m at Nadir 660m at extreme edges
- Source: Proba-V Products User Manual

Spectral and Radiometric Characteristics

Band name and centre wavelength (nm)	Band width (nm)	SNR @Lref($W\ m^{-2}\ sr^{-1}\ \mu m^{-1}$)
BLUE, 463	46	155 @111
RED, 655	79	430 @110
NIR, 845	144	529 @106
SWIR, 1600	73	380 @20
Radiometric performance		
Absolute accuracy		5%
Inter-channel accuracy		3%
Stability		3%

Source: Proba-V Products User Manual

Scene selection

- Level 1C segment products were used
- Processing steps for L1C
 - Geometric processing
 - Radiometric processing
- Output of radiometric processing is scaled TOA reflectance

Data Extraction

- L1C data are distributed as HDF5 format
 - Proba-V Product Customization Tool (PPT) was used to extract band image data
 - Map projection of L1C data was not supported.
 - GDAL was used to extract metadata
 - ENVI was used for image viewing and analysis
 - Continue to Work with Synthesis products to perform detailed Radiometric and Geometric analysis
-

Geometry

- **S1 TOA Products used**
- **Band 2 Band registration was performed**
 - Very well registered bands
- **Geolocation could not be satisfactorily performed**
 - More Study Needed and Ongoing

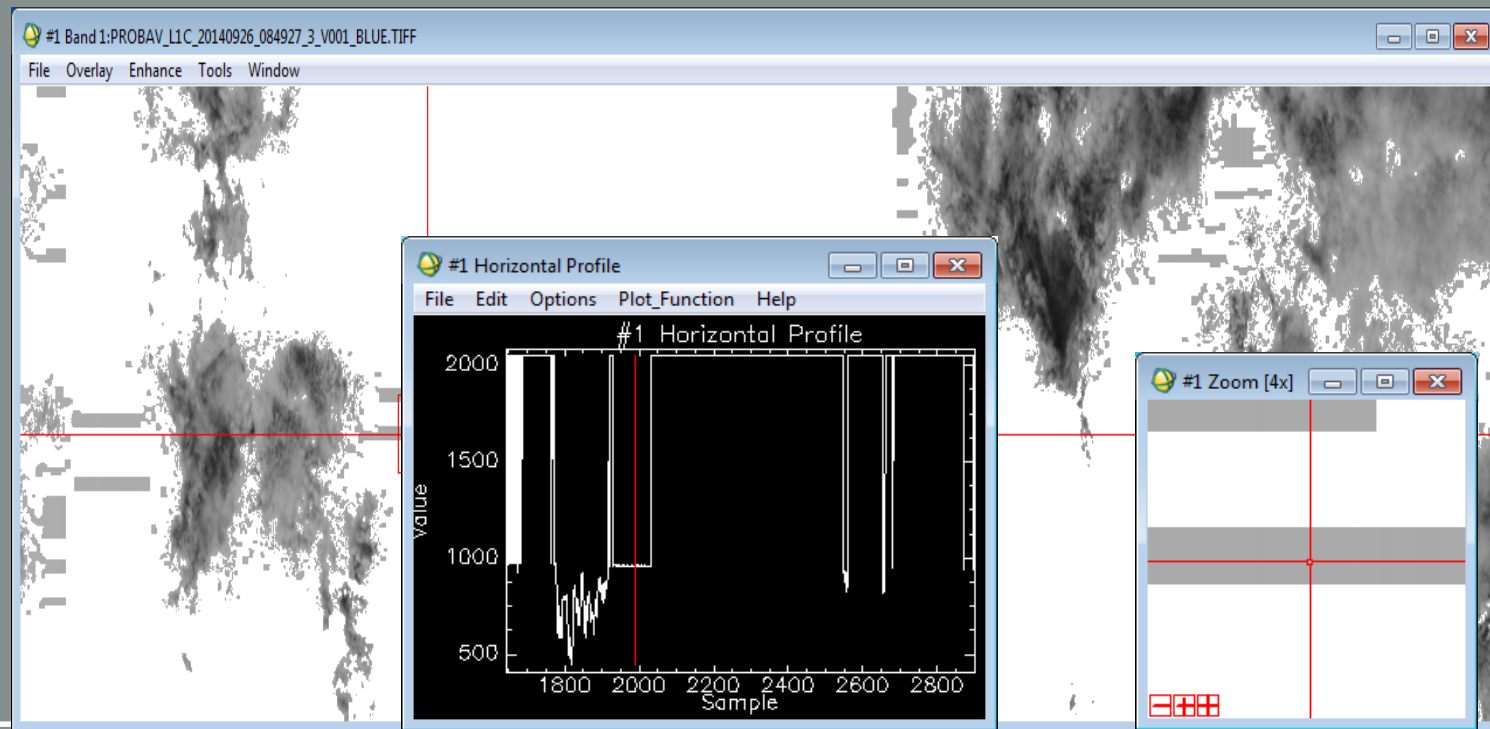
SCENE ID:

PROBAV_L1C_20140926_084927_3_V001.HDF5

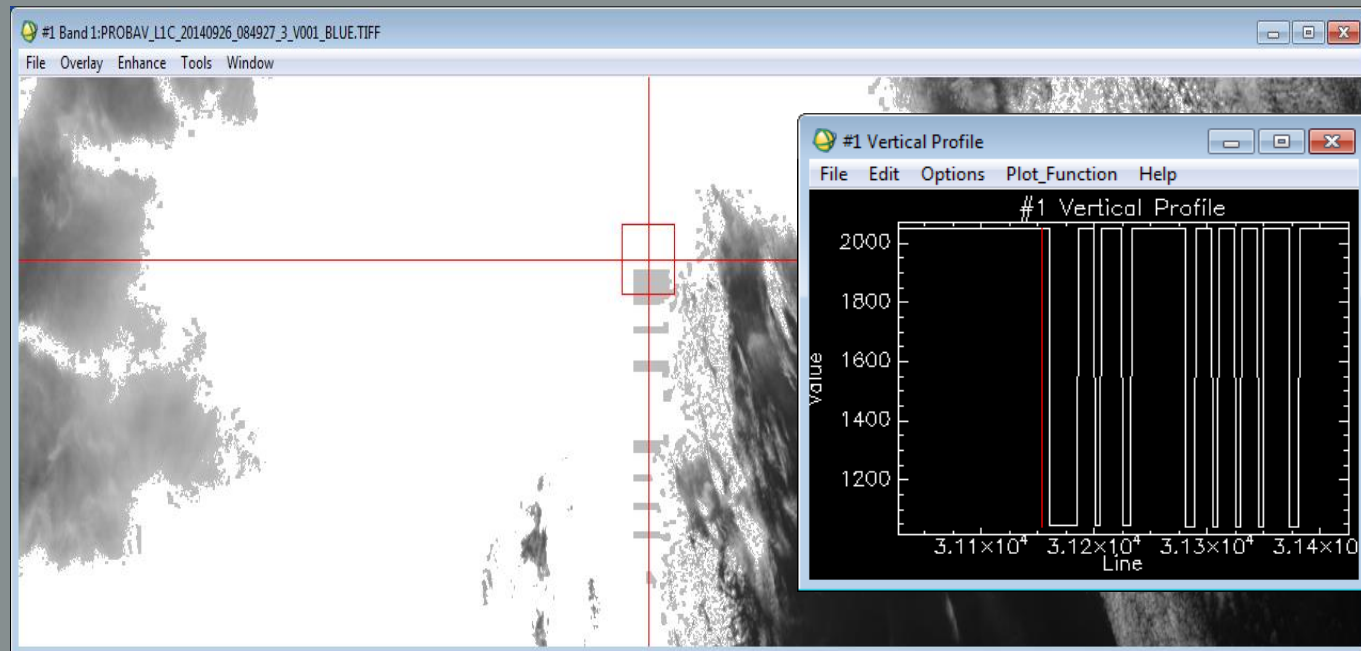
Right Camera

Blue Band

- Hi end saturation observed in cloudy areas
- Hi end saturation value 2047 DN or TOA reflectance of 1.0235

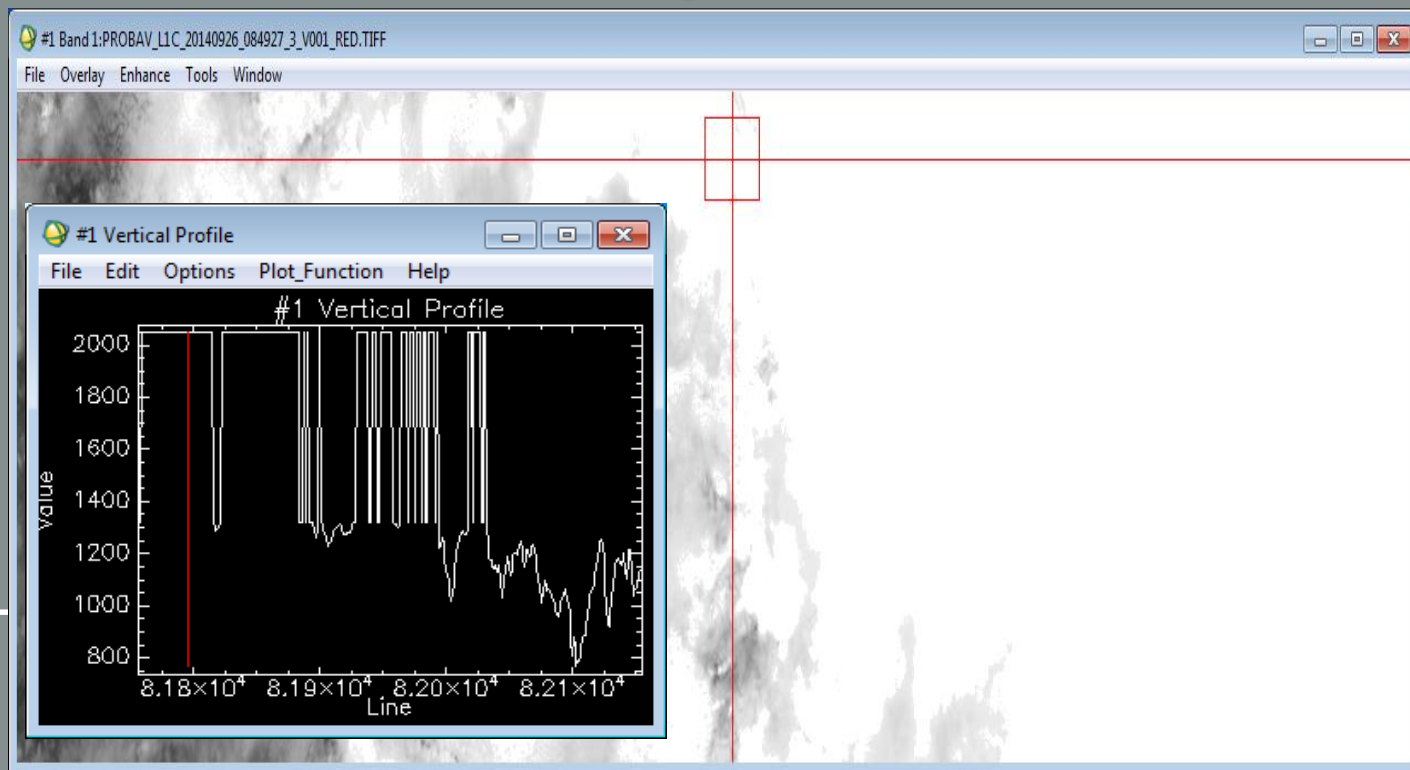


- Sometimes saturated detector response bounces back and forth between two signal levels
 - Usually seen near the edges of clouds
- Several detectors are affected



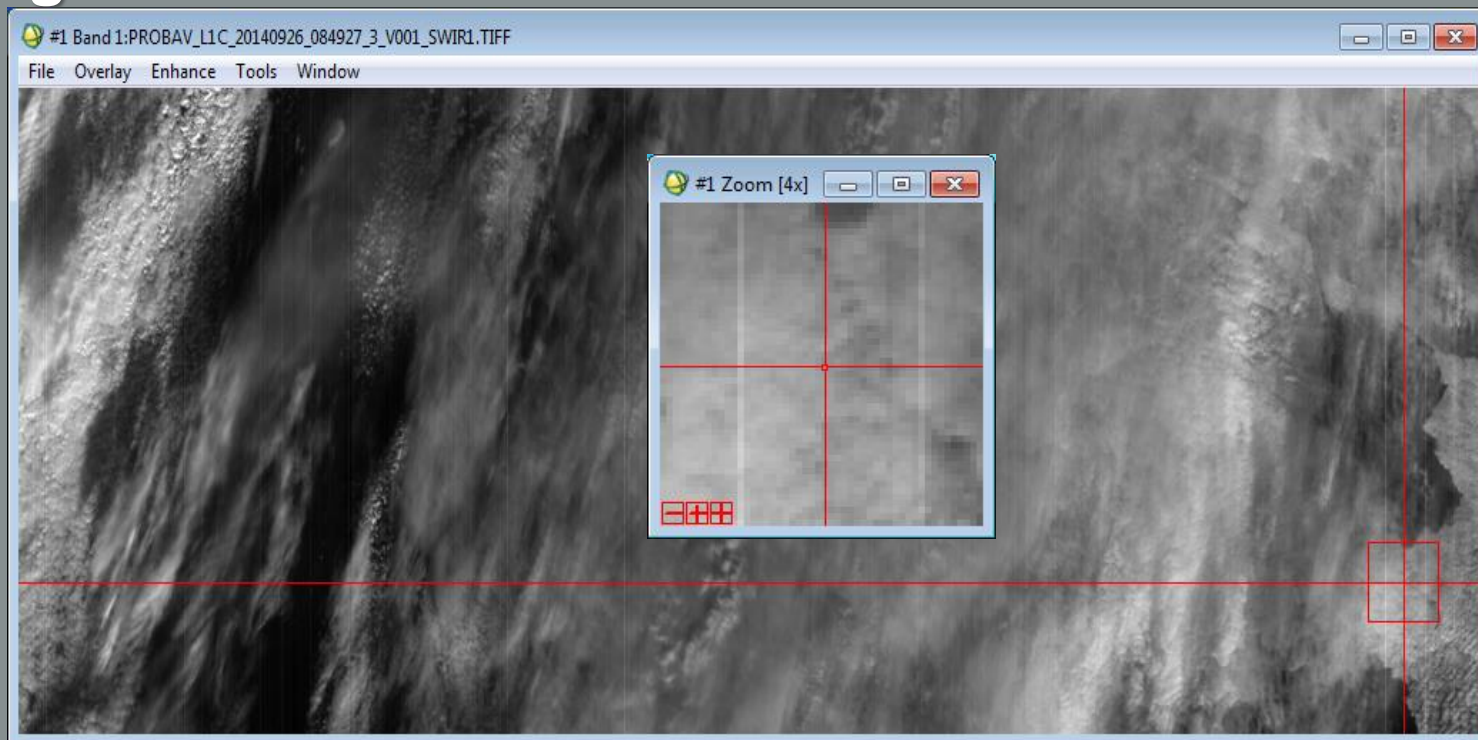
Red Band

- Hi end saturation observed in cloudy areas
- Hi end saturation value 2047 DN or TOA reflectance of 1.0235
- Sometimes saturated detector response bounces back and forth between two signal levels



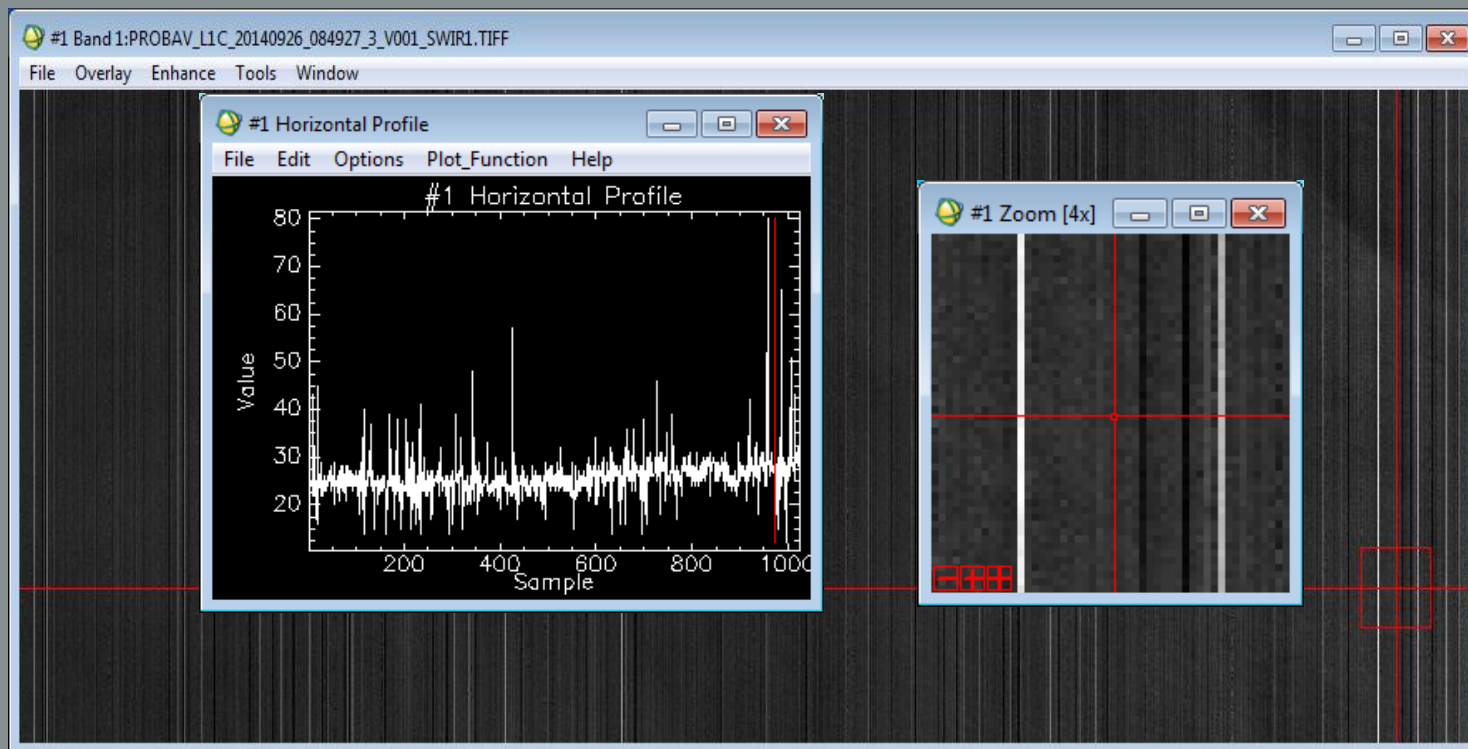
SWIR1 Band

- Some detector's responses are slight different than their adjacent detectors causing striping in the image



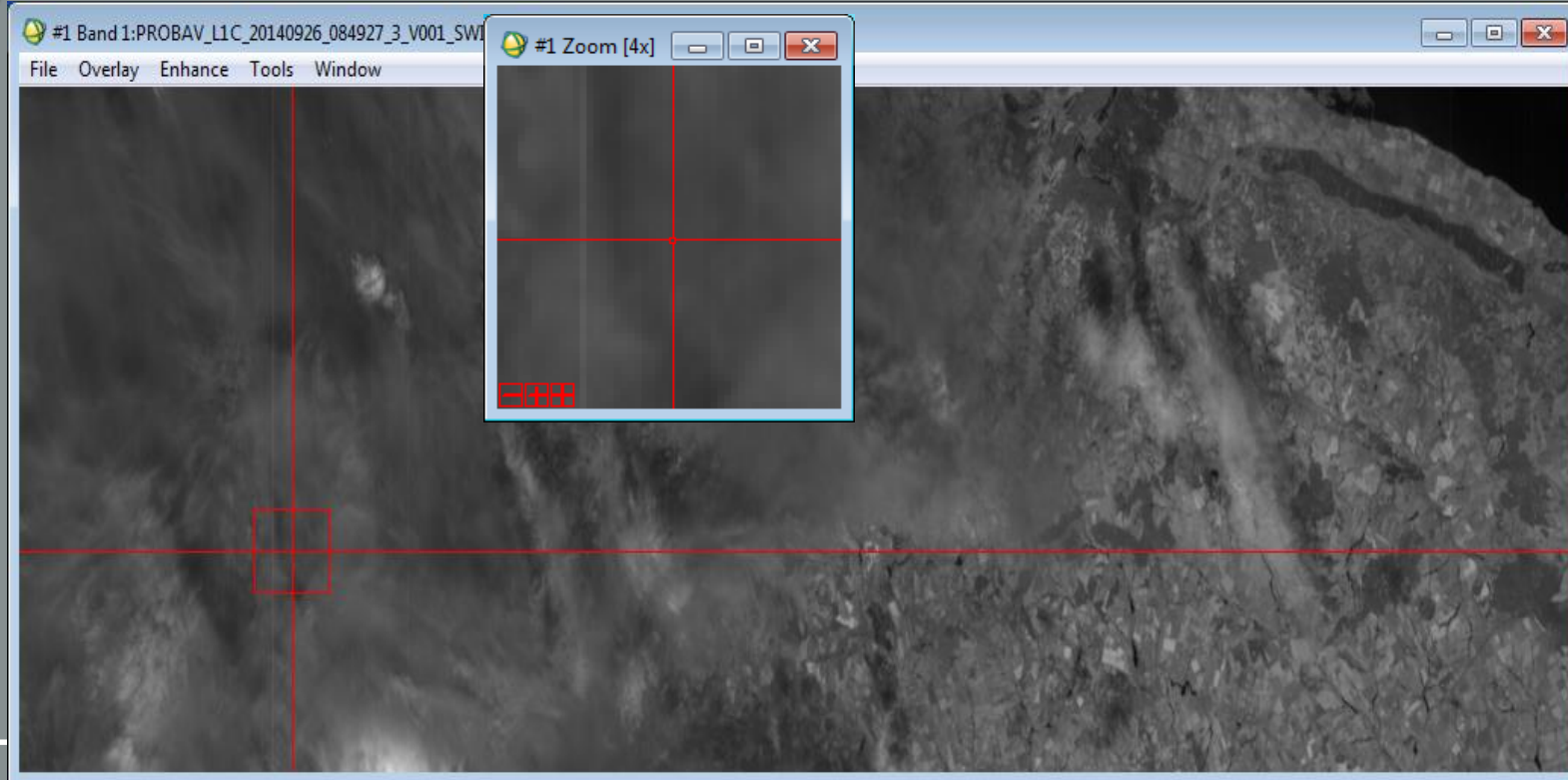
SWIR1 Band

- Some detector's responses are slight different than their adjacent detectors causing striping in the image
 - Easily visible in homogenous low signal areas



SWIR2 Band

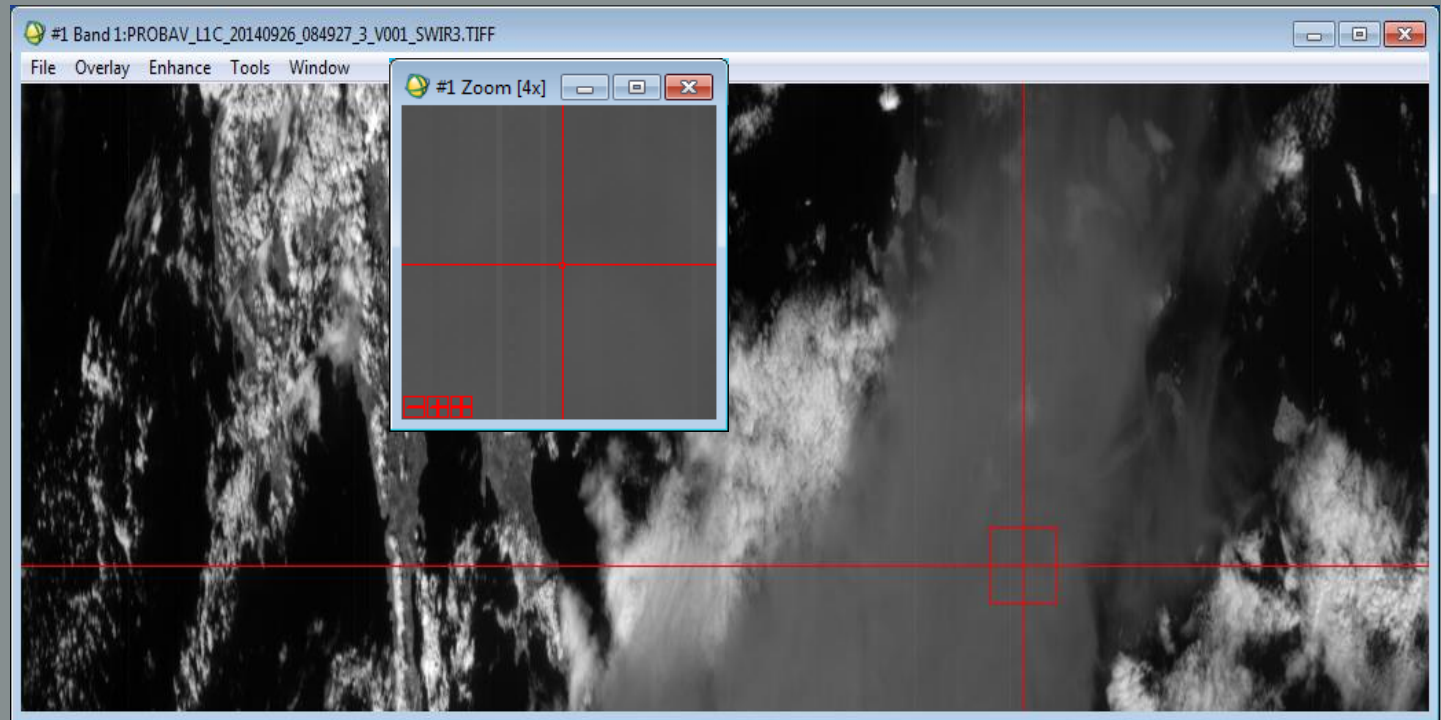
- Some detector's responses are slight different than their adjacent detectors causing striping in the image



SWIR3 Band

1/2

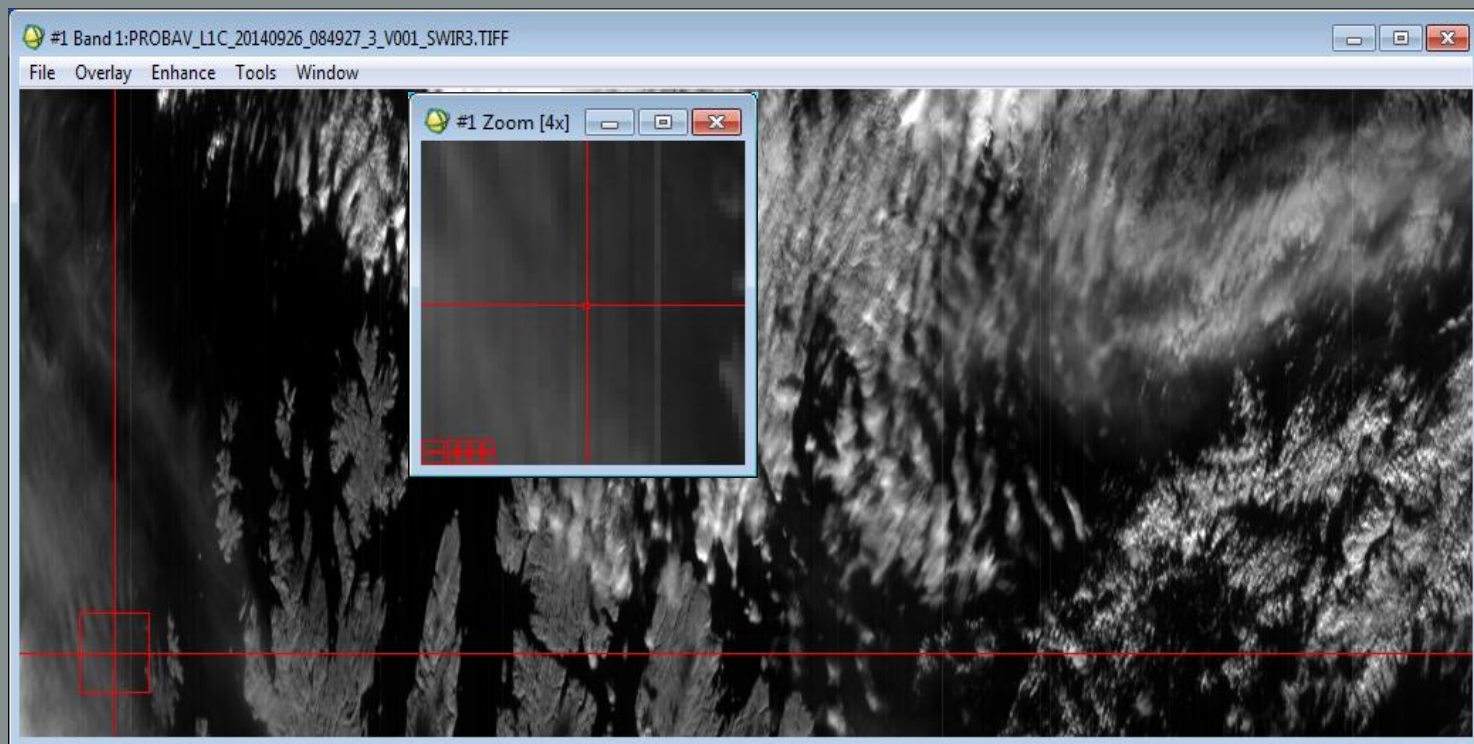
- Some detector's responses are slight different than their adjacent detectors causing striping in the image



SWIR3 Band

2/2

- Some detector's responses are slight different than their adjacent detectors causing striping in the image



Center Camera

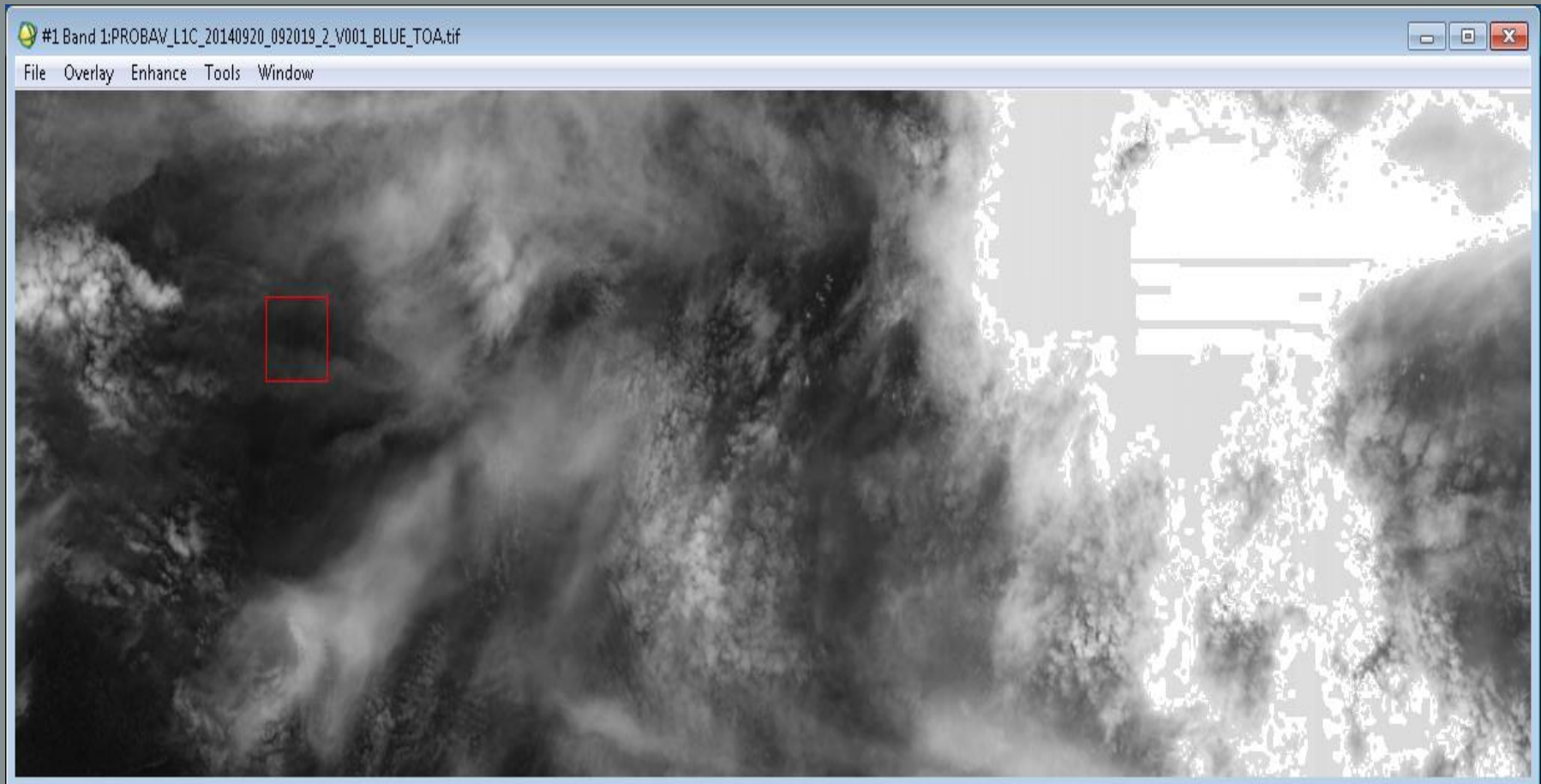
SCENE ID:

PROBAV_L1C_20140920_092019_2_V001.HDF5

Blue Band

1/2

- Hi end saturation observed in cloudy areas
- Hi end saturation value 2047 DN or TOA reflectance of 1.0235



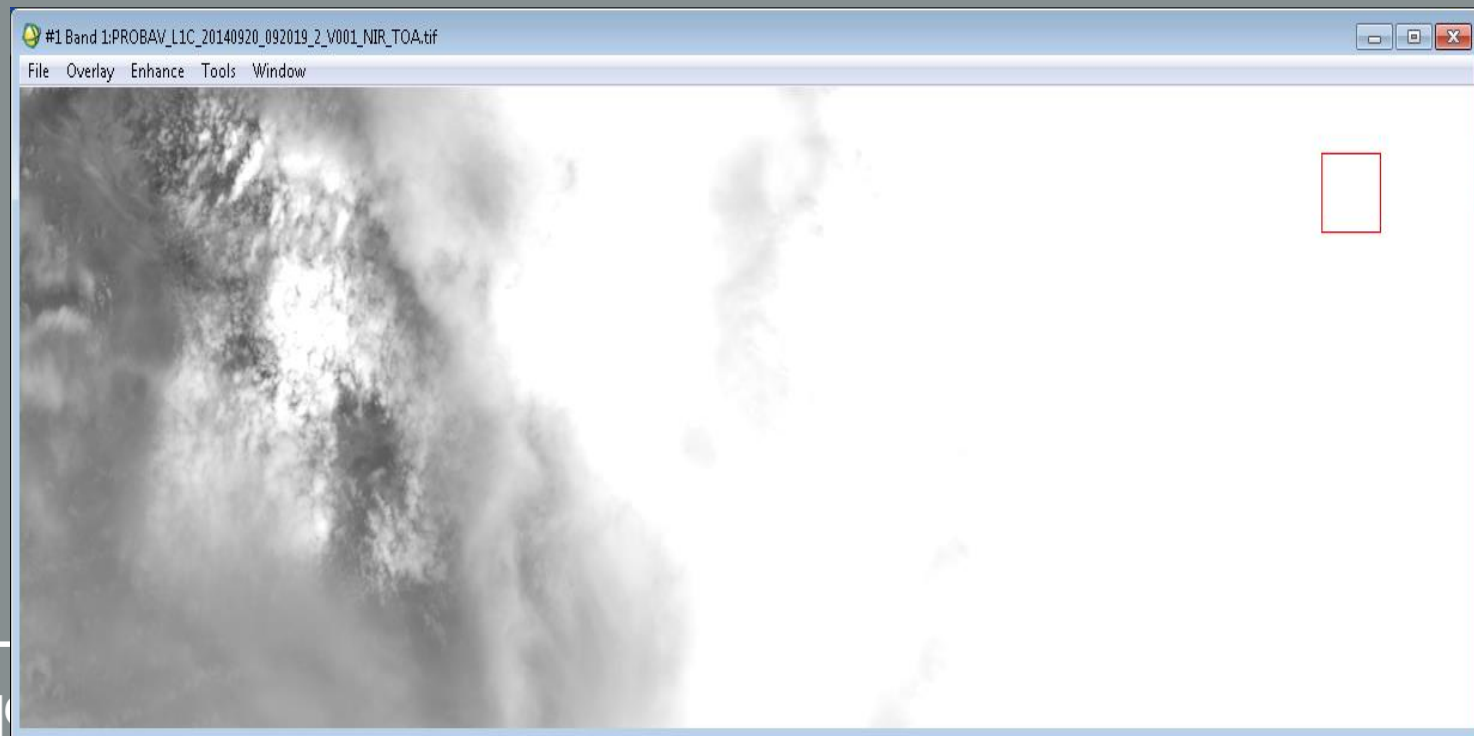
Red Band

- Hi end saturation observed in cloudy areas
- Hi end saturation value 2047 DN or TOA reflectance of 1.0235



NIR Band

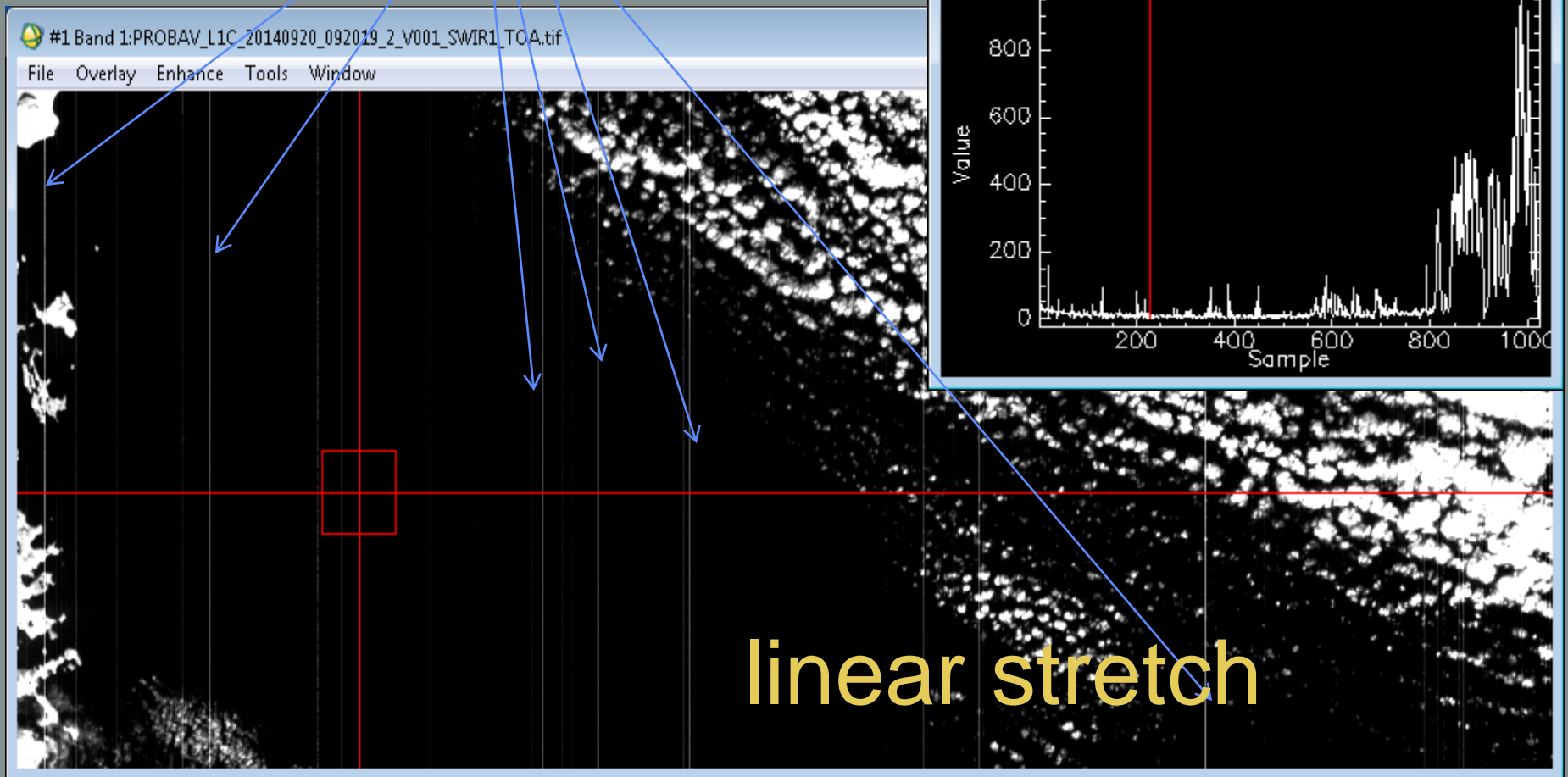
- Hi end saturation observed in cloudy areas
- Hi end saturation value 2047 DN or TOA reflectance of 1.0235



SWIR1 Band

1/2

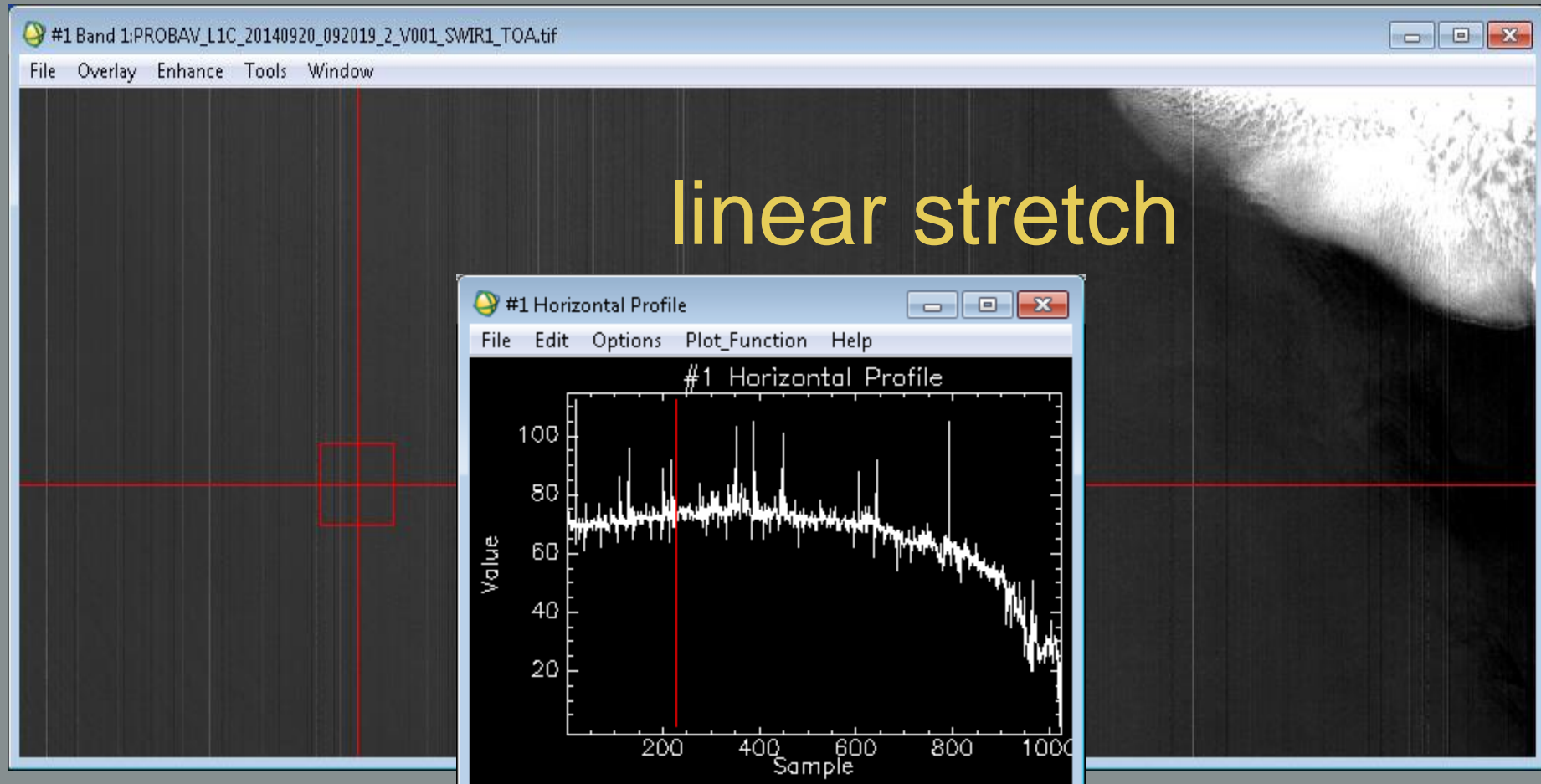
Striping



SWIR1 Band

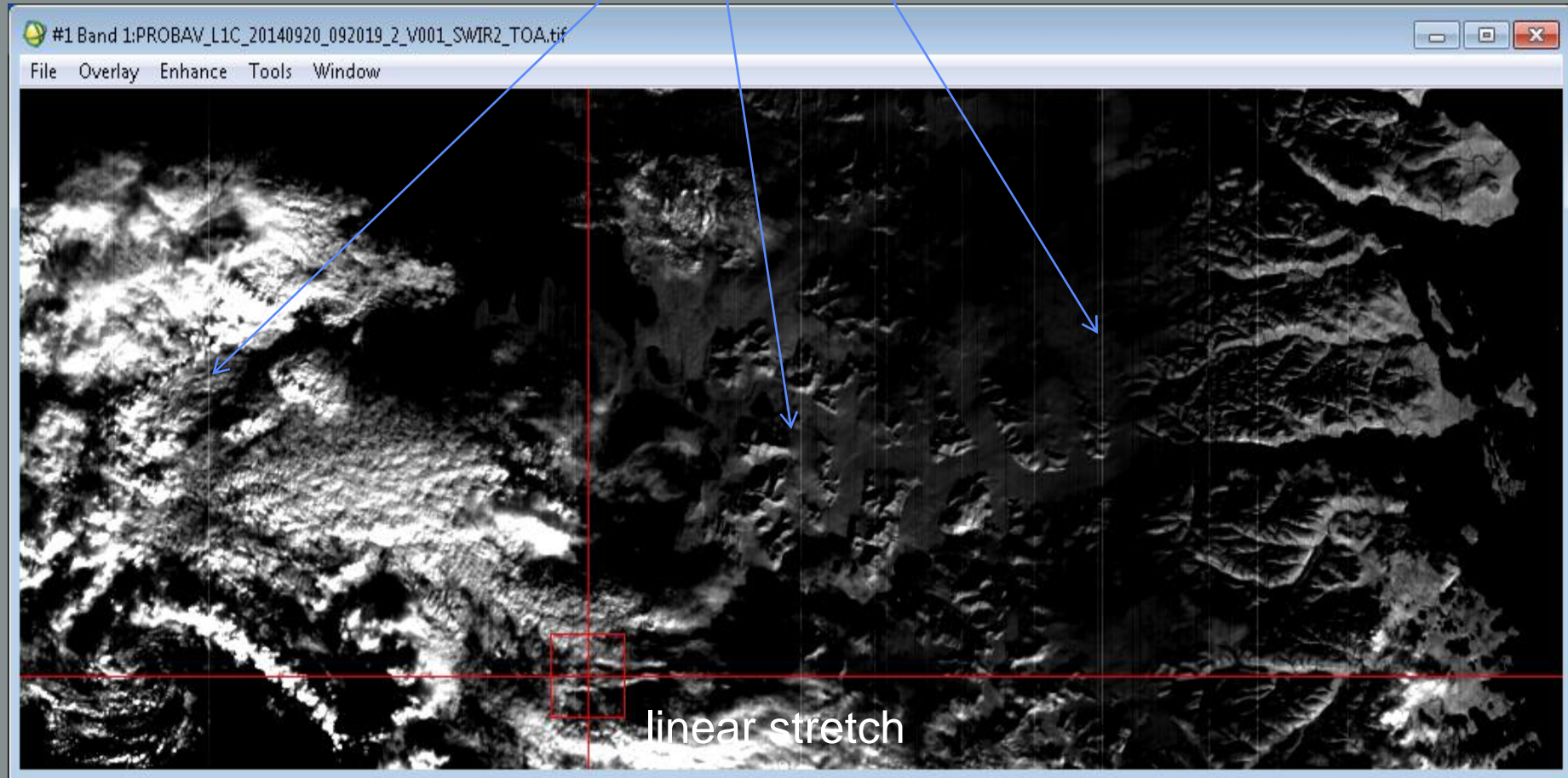
2/2

Striping



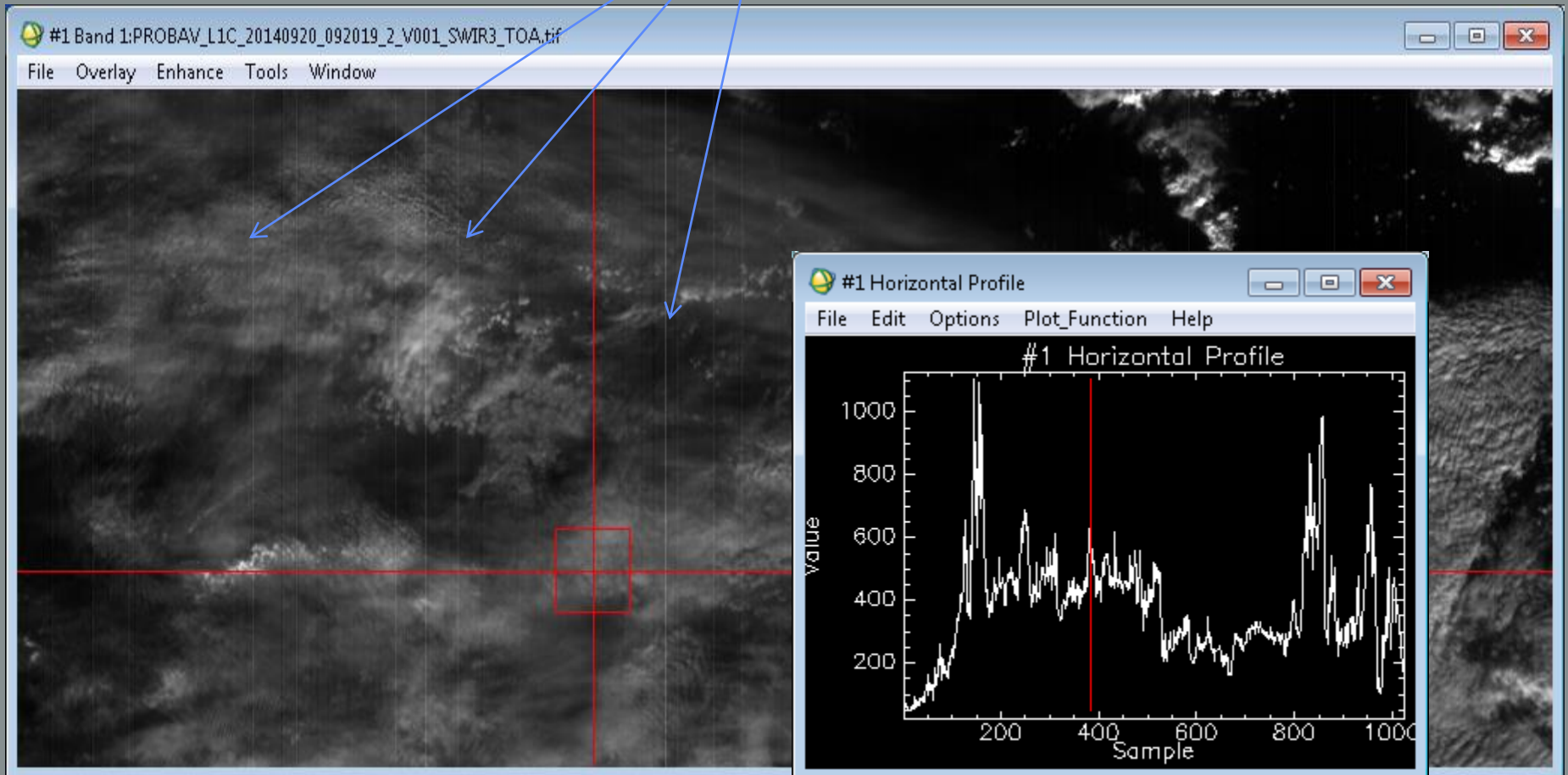
SWIR2 Band

Striping



SWIR3 Band

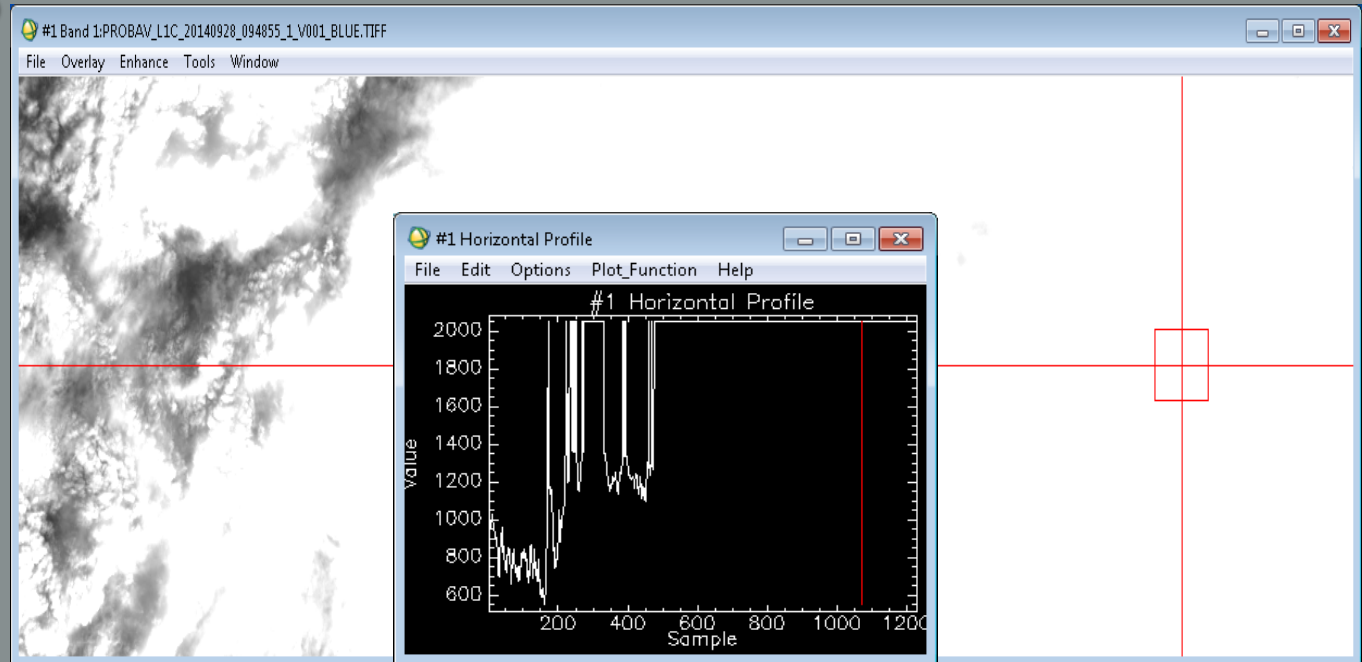
striping



SCENE ID:
PROBAV_L1C_20140928_094855_1_V001.HDF5

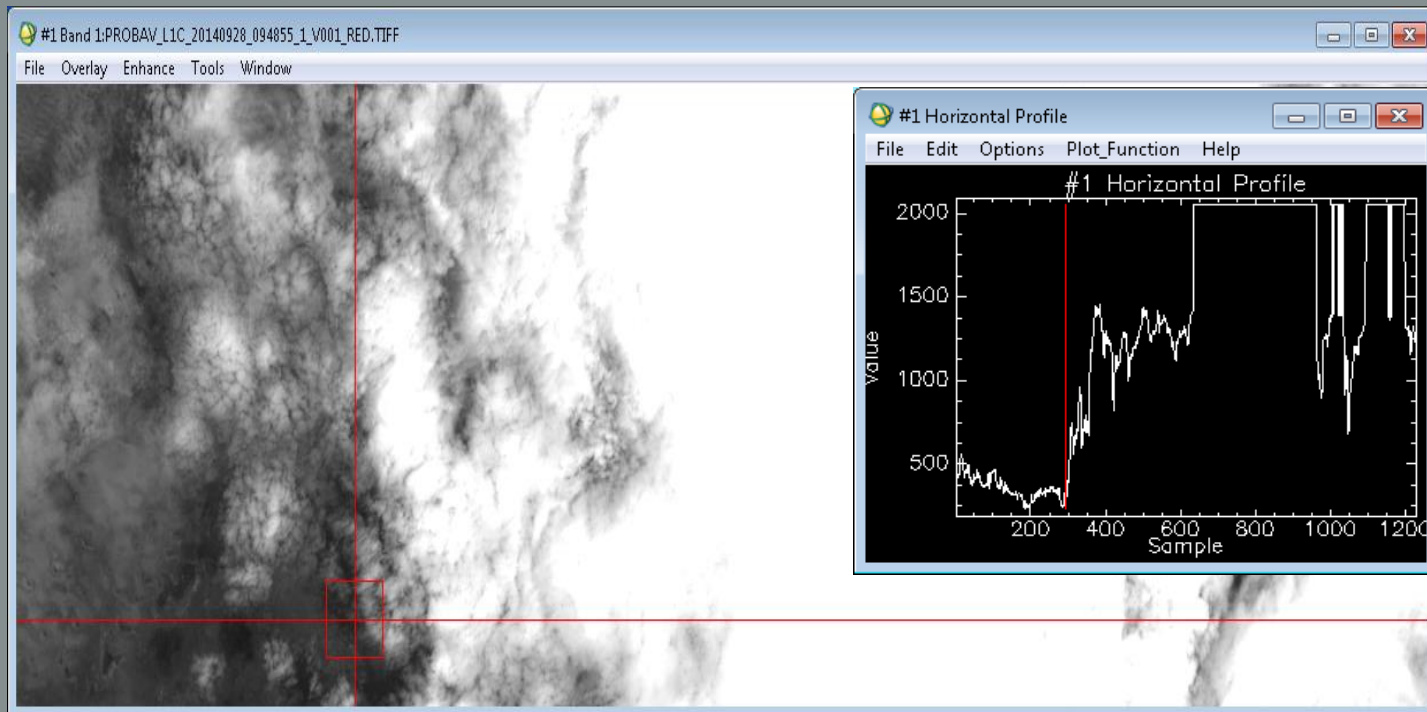
Left Camera

- Hi end saturation observed in cloudy areas
- Hi end saturation value 2047 DN or TOA reflectance of 1.0235



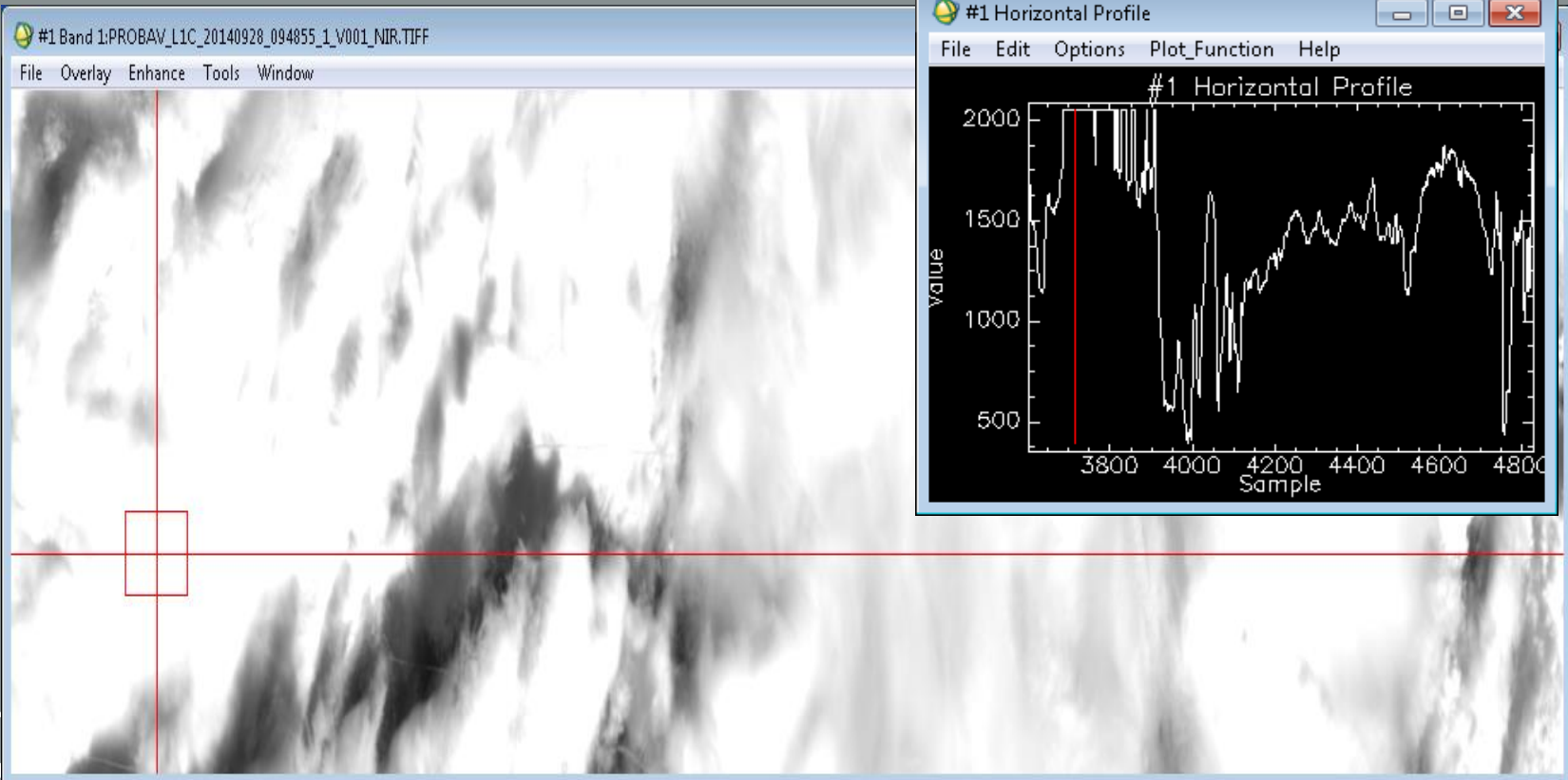
Red Band

- Hi end saturation observed in cloudy areas
- Hi end saturation value 2047 DN or TOA reflectance of 1.0235



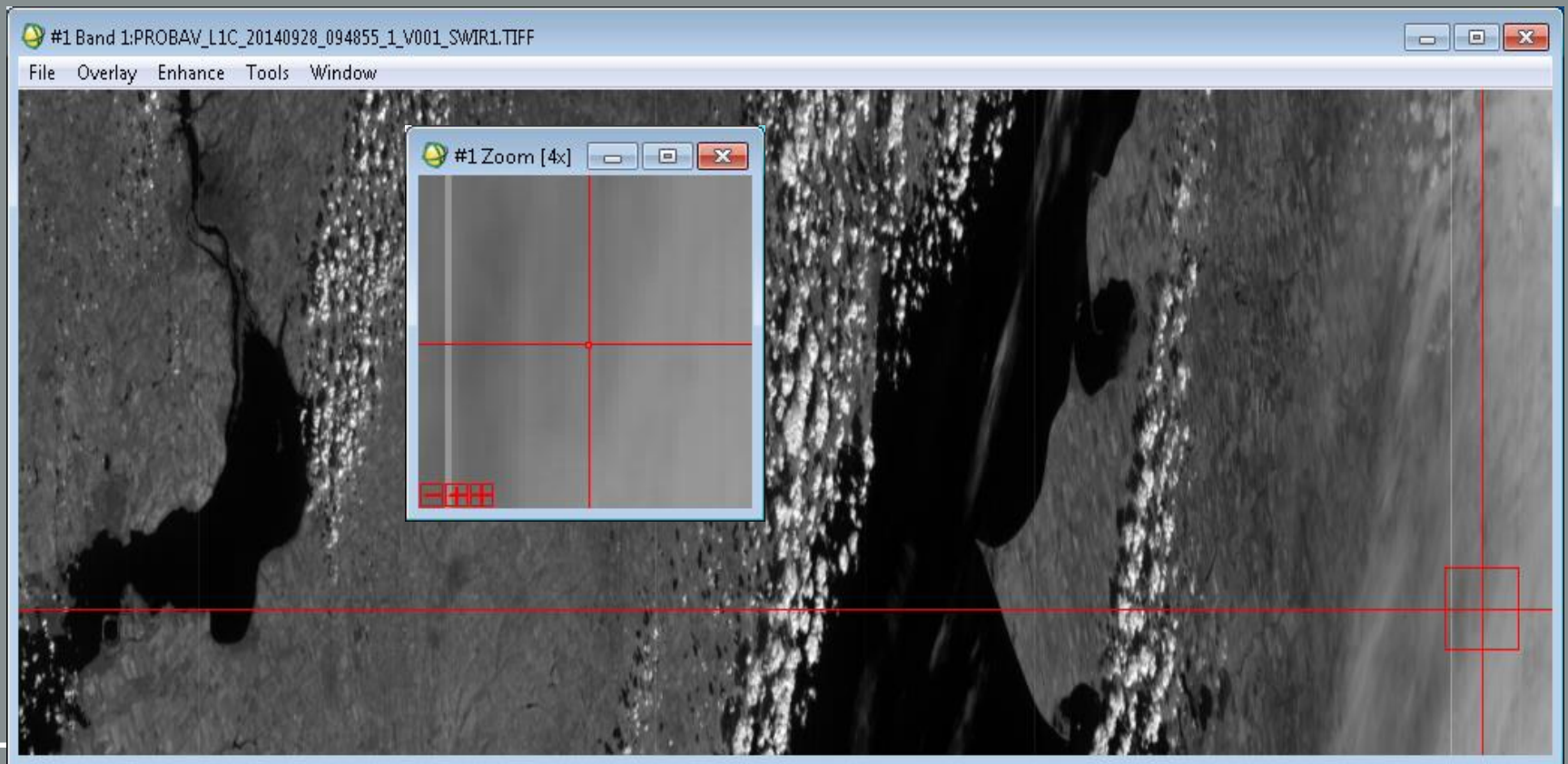
NIR Band

- Hi end saturation observed in cloudy areas
 - less common in NIR band
- Hi end saturation value 2047 DN or TOA reflectance of 1.0235



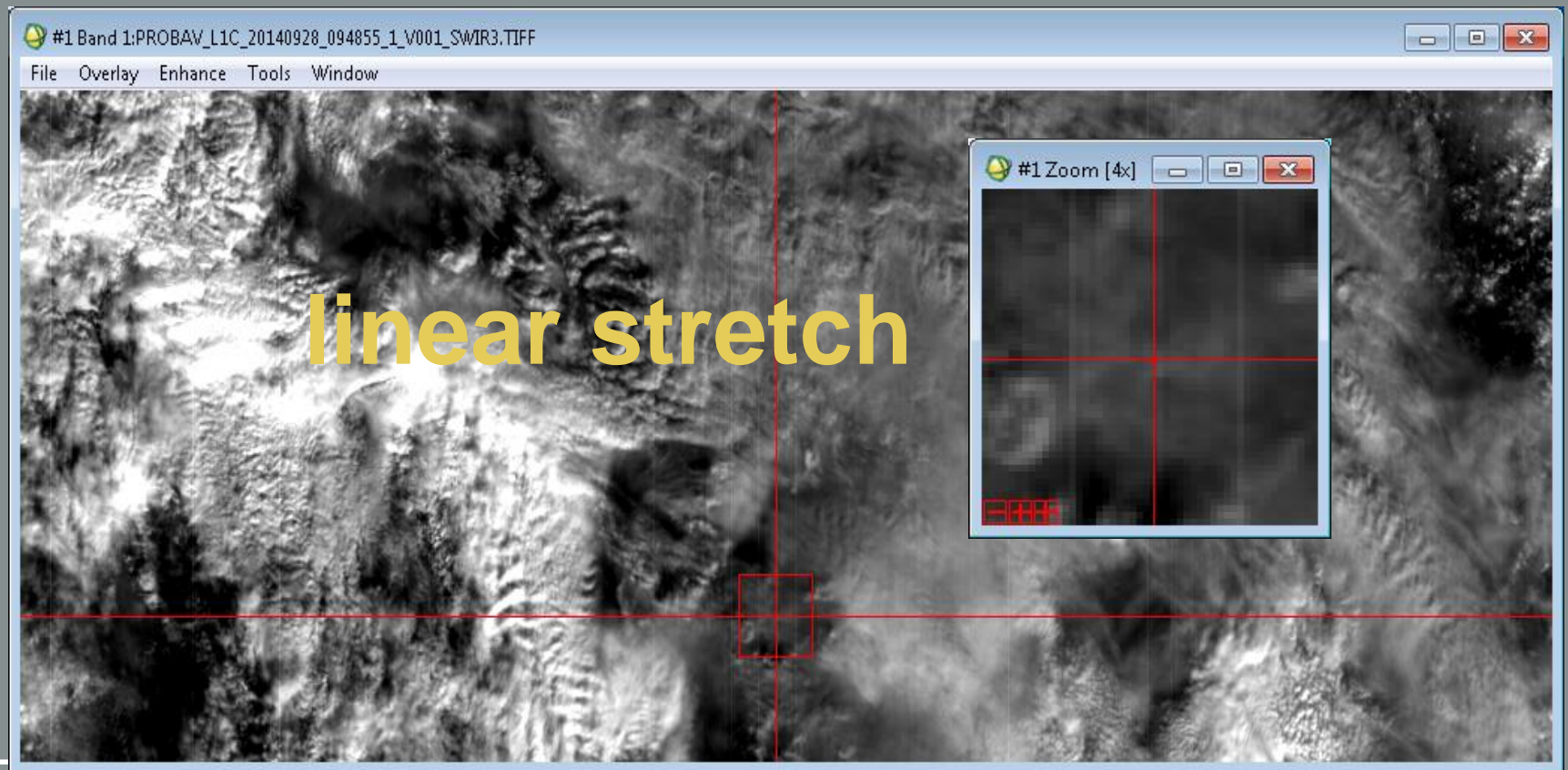
SWIR1 Band

■ Striping



SWIR3 Band

- Striping



Summary

- **Limited number of scenes were analyzed**
 - One scene from each camera
- **Hi end saturation was observed in V-NIR Bands**
 - Worst in Blue Band
- **Striping was observed in SWIR Bands**
 - Usually only few detectors are causing striping
 - Worst in SWIR1 Band
- **Future Work**
 - Continue to access higher products for further radiometric and Geometric analysis

Summary

- **WorldDEM and Proba V Characterizations**
- **Future Analysis:**
 - Continued data assessments for Medium resolution datasets ..
 - Elevation data characterizations
- **More data are welcome**
- **More collaborations welcome**